SAFETY PRACTICES IN CHURN DRILLING AT MORENCI BRANCH, PHELPS DODGE CORP. MORENCI, ARIZ.

BY ALAN A. SHARP AND ALLEN D. LOOK

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Alan A. Sharp[1] and Allen D. Look[1]

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1/ Mining engineer, Bureau of Mines, Phoenix, Ariz.

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INTRODUCTION

Churn drills for blast-hole drilling are important to the operation of most open-pit metal mines, but certain hazards are created through their use that cause fatal and nonfatal accidents.2/ The purpose of this circular is to present a code of safe practice prepared and followed at a large Arizona open-pit copper mine, where safety is recognized as a definite operating problem. Such a code, based upon a thorough study of available published information as well as practical experience gained from accidents and near accidents, is the result of considerable effort and monetary expenditure. It is hoped that other operations using churn drills may benefit by the code presented, either in comparison with existing rules or in the preparation of new operating instructions.

The code presented is in use at the Morenci Branch of the Phelps Dodge Corp., Morenci, Ariz. Similar codes are used at the New Cornelia Branch, Ajo, Ariz., and in the waste-pit operation at the United Verde Branch, Jerome, Ariz.

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GENERAL INFORMATION

The importance of churn drills in Arizona mining is apparent when it is realized that at all the open-pit copper mines blast holes are drilled with this equipment. At Morenci, approximately 98 percent of the ground is broken by primary blasting of churn-drill holes.

There has been a growing tendency in Arizona's copper-mining industry to change from underground to open-pit mining, with consequent increase in the use of churn-drill blast holes for primary blasting.3/

2/ Bureau of Mines, Electrical and Mechanical Hazards in Metal Mines: Metal Mine Accident-Prevention Course - Section 6: Miners' Circ. 56, 1946, p. 40.

3/ Millar, A. E., Adoption of Open-Pit Mining at Three Arizona Properties: The American Mining Congress, Paper presented at Western Section Meeting, San Francisco, Calif., September 1948, 6 pp.

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MORENCI CHURN-DRILL OPERATION

General Practice

Thirty-three churn drills are in use at Morenci for blast-hole drilling. The drills operate with 440-volt alternating current, and trailing drill cables, in 500-foot sections, connect with the portable drill transformer station.4/ Three Diesel-driven churn drills for drilling prospect holes also are in use. About 25 churn-drill shifts are operated currently on a three-shift basis. Ordinarily, a two-man crew is assigned to each drill; however, with prospect-drill crews a third man is added to handle the sampling.

Benches are carried at a uniform height of 50 feet. Churn-drill holes are 9 or 12 inches in diameter and about 60 feet deep. The holes are 18 feet apart in hard waste and 21 feet in soft waste and ore, with toes from 11 to 13 yards at the shovel grade. Both the hole spacing and the toe have been increased gradually, until they are now 2 yards longer than in 1940. The average ground broken per hole is 3,500 tons, or 60 tons of ore per foot of hole drilled. The holes are drilled 10 feet below the bench to avoid leaving hard bottom, which requires secondary drilling and blasting.

Starting with a 12-inch casing, the prospect holes average 1,200 to 1,500 feet in depth and terminate with 6-inch casing; the deepest hole drilled to date went to 1,735 feet.

In addition, churn-drills are used at Morenci to drill blast holes in the silica pit, limestone quarry, and the tailings dam. Other irregular applications are the drilling of holes to set trolley poles and for concrete piling in building foundations.

The average footage for all blast-hole drilling is about 79 feet per shift but may vary from an average of 50 feet in hard ground to 100 feet in soft ground. As underground mining was practiced at Morenci for many years, it is not unusual to drill into old workings, but no mishaps have resulted therefrom.

Every hole drilled in ore is sampled by the crew through a splitter on the bail box, which takes about a 10-percent cut. Every third hole in waste is sampled. For prospect holes, the engineering department employs its own sampler, who groups the cuttings into 10-foot runs. Water is poured in the hole after the casing is placed or soon after "spudding in" the hole. This is followed by a fine spray from a hose, the water supply for which is in a barrel mounted on a steel tripod. Pipe casing is left in 90 percent of the holes and is pulled out only when it obstructs the drill. Casing loss is about 5 percent.

Approximately 120,000 tons of rock is mined daily, of which 50,000 tons is ore. Blasting generally follows close after churn drilling, and

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4/ Hyvarinen, J., and Look, Allen D., Safe Electrical Practices in Two Arizona Open-Pit Mines: Bureau of Mines Inf. Circ. 7494, 1949, pp. 6-8.

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will average 50 to 60 holes a round in single lines fired simultaneously. In straightening out "ragged" banks, double rows of holes are blasted. Although this reduces blasting efficiency, it also reduces the over-all cost because of the saving in shovel loading.

Sharpened churn-drill bits are delivered in special trucks to the various drill crews, at which time the dull bits are picked up and returned to the shop. Over 9,000 bits are handled yearly.

CODES OF SAFE PRACTICE

Each employee of the Morenci Branch open pit is given a pamphlet, known as a "Code of Safe Practice," containing detailed instructions for the particular job he is to do. In some instances, the employees may have more than one occupation and may need more than one such code.

Codes of Safe Practice, now used at the various Arizona branches of the Phelps Dodge Corp. originated at the United Verde Branch, Clarkdale, Ariz. Two Bureau of Mines Information Circulars describe the codes used at a smelter5/ and an underground mine.6/

Responsible officials and experienced bosses were selected for the task of drafting the codes, which were revised and edited by the foremen, shift bosses, selected workmen, superintendents, and the safety department before printing. The codes published by the United Verde Branch serve as a reference for the other branches, but each department had to draw up individual codes particularly applicable to its own operation. Each employee on churn drills receives a copy of the "Code of Safe Practice for Churn Drilling" or the "Code of Safe Practice for Open-Pit Division Prospect Drilling" (if working on one of the prospect drills) and is examined on the contents. The code is reviewed by the men at regular intervals.

Code of Safe Practice for Churn Drilling

The Code of Safe Practice for Churn Drilling is as follows:

I. Services to be Performed and Not to be Performed

1. The services to be performed are mainly those of drilling churn drill holes. They also include moving the drill, inspection, lubrication of the machine, and minor repairs.

2. The services not to be performed are:

   a. Making major repairs.
   b. Attempting to make electrical repairs.
   c. Blasting operations.

5/ Anundsen, E. A., Accident Prevention at a Copper Smelter: Bureau of Mines Inf. Circ. 7061, 1939, pp. 12-16.

6/ Look, Allen D., and Sharp, Alan A., Safety Practices at United Verde Mine, Phelps Dodge Corp., Jerome, Ariz.: Bureau of Mines Inf. Circ. 7501, 1949, pp. 6-9.

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II. Obvious Hazards

1. Danger of electric shock from trailer cable. Handling with hands or stepping on cable.

2. Danger of electric shock from metal objects in contact with cable, or mast in contact with power line when moving drill.

3. Danger of moving drill while partner is not in view.

4. Danger from having too much slack in sand line while bailing or running line too fast.

5. Danger from being struck by bailer.

6. Danger from being struck by tools.

7. Danger of mud splashing in the eyes while emptying bailer.

8. Danger of dropping wrenches or tools on feet or hands.

9. Danger of dropping bits or casing while handling same.

10. Danger of cutting hands on rough edges of casing.

11. Danger of getting fingers caught in casing slots.

12. Danger of rocks, tools, or equipment dropping from mast.

13. Danger from operating drill with poor clutches or brakes.

14. Danger from not wearing goggles while picking or when eyes are exposed to flying particles.

15. Danger from not wearing gloves while handling material.

16. Danger from not seeking shelter from nearby blasting.

17. Danger of falls from mast, platform, or over bank.

18. Danger of being struck by railroad equipment, trucks, or cars.

19. Danger from tripping hazards on deck or around drill.

20. Danger of burns from fires or hot stoves.

21. Danger of slipping on muddy or icy deck.

22. Danger of falling from transportation truck.

23. Danger of stepping into uncovered drill hole.

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III. Crew Duties and Responsibilities

A. Personnel

The churn-drilling crew personnel is composed of a driller and a helper.

B. Qualifications

1. Churn driller

   The churn driller should have a thorough knowledge of the churn drill and should be able to operate the drill in a safe and efficient manner.

2. **Churn-drill helper**

   No special qualifications are required of a churn-drill helper other than that he should have a sturdy physique, some knowledge of machinery, and other natural requirements that would fit him for the work.

C. Training for the Job

1. Churn driller shall have served sufficient time as a helper to enable him to become thoroughly familiar with all of the duties pertaining to the operation of a churn drill. He should be able to operate the drill both safely and efficiently and make minor repairs.

D. Reception and Training of Churn-Drill Helper

1. The churn-drill helper receives safety instructions from the Safety Department before starting to work.

2. He receives additional safety instructions and specific job instructions from the churn-drill foreman.

3. The churn driller will instruct his helper on the following operations:

   a. How to stop drill in case of emergency.
   b. Handling trailer cables and switches.
   c. Precautions on moving equipment, how to signal, and where to stand when drill is being moved.
   d. Handling wrenches, bits, and casing.
   e. Lubrication of drill.
   f. Any other instructions necessary for the safe and efficient operation of the drill.
   g. Permission shall be received from the churn-drill foreman before starting to break in on the drill.
   h. The helper shall become proficient in handling the bailer before he is allowed to handle the other controls.

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4. Breaking in Helper

a. Breaking in of helpers to handle the controls of the drill must be a careful and gradual process.
b. Before turning a new helper over to a driller for duty, the churn-drill foreman must personally explain the mechanism of a drill to the man, making sure that he is sufficiently instructed to be able to stop the machinery in case of emergency.

c. Before giving permission for a helper to break in, the shift foreman must consult the general churn-drill foreman and the drillers who have worked with the man under consideration to eliminate persons who are not adapted to churn drilling. Helpers who have the natural qualifications which would fit them for the work, but who have had no previous drilling experience, should be required to learn thoroughly the duties of a helper before they are allowed to handle the controls. One month is the minimum time to meet this requirement.
d. The breaking-in process will start with instructions and practice in the use of the bailer, bearing in mind that care must be exercised in teaching a new man to control the bailer if an accident is to be avoided. Two full weeks' practice with the bailer alone must be allowed before attempting to teach the man the use of the other controls.
e. If after a period of two weeks the man seems to be proficient in the use of the bailer, and if his general progress seems to justify it, the foreman may allow the man to be taught the handling of the string of tools and the other duties of a driller.
f. When a helper has learned to handle the controls safely, it is desirable that he be allowed to practice as much as possible, consistent with maintaining a satisfactory drilling rate.

E. Duties of Crew Members

1. Churn drillers

a. The churn driller receives his orders from the churn-drill shift foreman.
b. He is responsible for keeping the drill operating full time.
c. He is responsible for the condition of the machine.
d. The driller must supervise the inspection and greasing of the machine.
e. Driller shall not allow helper to run machine until he is certain that helper thoroughly understands the operation of the machine. The churn-drill foreman shall authorize helper's running machine.

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f. He is responsible for the safety of his helper and seeing that he carries out his duties.
g. Driller is responsible for having himself or his helper within easy reach of the controls of the machine at all times when drill is operating.
h. The driller is responsible for keeping the jack tight under the machine.
i. The driller must check hole stakes for depth and number and record this information in his report.
j. The driller must take samples when stakes at the hole indicate that they are required.
k. The driller is responsible for seeing that samples are protected.
l. The driller is responsible for submitting a correctly made report on the form furnished.
m. Drillers and helpers shall ride in a sitting position on the transportation truck.
n. Getting on or off moving truck is prohibited.
o. Smoking on transportation trucks is forbidden.
p. In the absence of the foreman, the truck driver is in charge of the truck, and he is responsible for the safety of the riders.
q. When drill is to be shut down and out of service, the drill should be moved from the bank, and the power should be shut off at the transformer.
r. Discuss any out-of-routine moves or work with the churn-drill foreman and be sure that the proper procedure is understood.

2. Helper

a. The churn-drill helper receives his orders from the churn driller and the churn-drill shift foreman.
b. He is to assist driller in the operation of the drill.
c. Grease and help inspect the machine under the churn driller's supervision.
d. Keep open holes covered.
e. Build runway for sludge.
f. Keep samples and equipment out of the way of the machine when moving.
g. Keep the machine clean, arrange supplies and power cable in an orderly manner, and do not allow trash to accumulate in the vicinity of the drill.

F. Apparel

The churn driller and helper are required to have the following safety equipment on their person at all times:

Hard-boiled hat
Hard-toed shoes or boots
Respirator (when working conditions are dusty)
Goggles
Gloves

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IV. Equipment and Material

A. Machinery

An electric drill, complete with drilling tools for drilling nine-inch holes, is standard equipment.

B. Tools

The tools for drilling operation include:

Circle jack and handle
Screw jacks and bar
Swivel wrench and chain block
Two pair cable tongs
Casing driver
Safety belt and chain
Cable cross-overs
Cribbing timbers and blocks
Casing puller
Cheater block
Cross blocks
Oil can
Water barrel and stand
Water hose
Water bucket
Grease gun
Pick
Shovel
Wrenches
Sample cutter and cans
Hole covers, etc.

V. Preparation and Housekeeping

A. Inspection of equipment

1. When safety and working conditions require, power must be shut off when repairing and oiling machine. Be sure that switch lever at transformer is pulled all the way down before attaching cables or making repairs.

2. Nothing but standard fuses may be used on motor or light circuits.

3. Inspect braces, nuts, shock absorbers, and look for rocks or loose equipment. Make inspection on day shift and afternoon shift while lubricating sheaves.

4. The driller must inspect chain blocks and trolley at the beginning of each shift.

5. Inspect drill line, sand line, electric power, brakes, clutches, and other mechanical parts which might affect the operating efficiency or safety of the machine.

6. Inspect the power cable for cuts and breaks each day. Notify electrician if defective cable is found, do not attempt to make repairs.

7. Operators may change light globes and make cable connections. All other electrical repairs will be made under the supervision of an electrician.

8. When moving to another drill during the shift, the drill must be inspected and lubricated as is required.

9. Supplies and repairs needed must be reported to the churn-drill shift foreman.

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B. Illumination

1. The churn drills are wired and provided with electric lights for night drilling.

2. The lights should be of sufficient power to provide ample illumination.

3. Broken lights should be promptly replaced, and light bulbs should be kept clean.

C. Lubrication and Operating Repairs

1. Drill crews must not attempt to oil or repair moving machinery. The cats may be greased while drilling is in progress, but for all other greasing operations, the power control must be in neutral position.

2. The churn drill is lubricated by the helper under the supervision of the driller. Parts should be lubricated with the proper lubricants as specified.

3. All important bearings are provided with pressure grease fittings. These should be wiped clean and lubricated daily or more often when specified.

4. Crater compound shall be used on cable drums as often as is necessary to keep the cables well lubricated.

5. Sprocket chains and cats must be greased each day shift.

6. Crown-sheave bearings and bailer-sheave bearings must be greased at the beginning of day shift and afternoon shift. The mast should be inspected for broken or loose parts at this time.

7. Clean and lubricate jacks daily.

8. Wear a safety belt and have it properly secured while working on mast or any other part of machine where the footing position is more than 6 feet above the ground level.

9. When drill line is being straightened on the drum, slack must always be taken up from the spudding beam.

10. Be sure that motor is shut off when straightening line on drums.

11. Avoid using hands when guiding cable on drum. Use a stick or tools.

12. Grease guns and containers, when not in use, must be cleaned, filled, and kept on the rack.

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13. The driller shall report condition of drill and bad order tools or equipment on his daily report.

14. The metal plates which separate the rubber disks in the derrick head are fitted with graphite bushings and require no lubricant. Keep the rubber disks as free as possible from oil and grease.

D. Repairs

The duties of the repairmen include replacing cables, socketing cables, moving drills, lowering and raising masts, replacing shafts and gears, and supervision of cutting and welding at drill.

1. Wear a safety belt when working on the mast.

2. Wear goggles and gloves while handling molten metal or acid.

3. Never pour hot metal into a wet socket.

4. Be sure that mast is properly anchored when lowering same.

5. When replacing gears or shafts with chain block, make sure they are properly secured for lifting.

6. Use proper lifting methods when moving equipment by hand.

7. Protect the eyes from a flash when cutting or welding is being done.

8. Be sure that power switch at the transformer is pulled all the way down when it is necessary to remove the power from the trailer cables.

E. Housekeeping

The churn-drill helper is responsible for the good housekeeping around the drill.

1. Power cable should be neatly coiled, with enough cable at the machine to make the move to the next hole.

2. All tools should be kept in their proper places and not left lying around.

3. Grease and other lubricants shall be properly stored after being used.

4. Keep drill bits, casing, cribbing and other equipment where they will not be a tripping hazard to workmen at drill.

5. Hang up cable tongs when not in use, so that they are readily obtainable when needed.

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6. Oily waste or rags should be picked up and burned.

7. Open fires for warming purposes or for heating lubricants are prohibited. Approved-type portable stoves must be used.

8. Keep the platform and deck clean of all materials and tools except those needed for changing bits.

9. No scrap iron or broken-metal churn-drill parts should be left lying around. Pick them up and place them where they will be gathered up by the scrap-salvage crew.

10. Blocks, cribbing, and crosses must be kept in neat piles when not in use.

VI. Procedure and Precautions

A. Moving Drill

1. In all references to the drill, the back of the drill is the end where the derrick and drill platform are located. The right side is the side nearest the right hand while facing derrick.

2. The churn driller is responsible for the moving of the drill from one hole to another.

3. When moving drill, avoid damage to hose, pipe lines, power cables, or other property.

4. Never move the drill unless the helper can be plainly seen and understands what is to be done. Be sure that helper understands the method of signaling.

5. Drill crews must turn off power before making cable connections.

6. The helper shall see that road for movement to the next hole is clear before moving starts.

7. When necessary, the helper will give signals to assist the driller in moving or spotting the drill in the proper position.

8. The helper will keep the power cable in the clear of the drill at all times.

9. Always use the cable tongs when handling power cable unless it is definitely known that the power has been cut off.

10. When moving, the bailer should be in the mud box and the sand reel lever latched. See that there is no slack in the sand line.

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11. Before the churn drill is moved, all equipment on the tail board must be made secure. The bottom of the tools must be 6 inches below the deck, and the tool guide must be securely tightened.

12. Drill crews must take every precaution to protect power cable. They must bridge the cable over water holes, sludge, pipe lines, shovel power cable, and roads. All of the slack should be coiled and all tools, rocks, and other heavy material kept off the cable.

13. Keep the cable in the clear of roads where it may be damaged by traffic.

14. Use the approved cable bridges when it is necessary to cross over trailer cables.

15. There must be a clearance of 6 feet between near end of railroad ties and part of drill nearest the track.

16. When handling power cables with tongs, do not step on the cable or allow the cable to brush against the body.

17. Churn drills being moved near high-tension lines must be under the direction of the foreman.

18. When moving shovels or churn drills under interferring power lines, adequate instructions and supervision must be given by the electrical department to insure that all lines are dead.

19. No one except electricians will be permitted to take hold of wires and move them over churn-drill booms.

20. In event that the mast must be lowered, the lower end must be anchored by chain blocks as well as by the winch cable while repairmen remove the cable guide and short braces.

21. When churn drills are being crossed over railroad tracks, a flagman must be stationed on each side of the drill to stop trains.

22. The driller must not allow his machine to remain near the crest of a bank which he does not consider safe. When in doubt consult the churn drill foreman.

23. Avoid damaging or losing hole stakes.

24. Motor control must not be moved to a reversed position until motor has stopped.

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B. Setting Up and Leveling Drill

1. The churn drill should not be set up parallel to the bank or within 30 feet of power line without special permission from the churn-drill foreman.

2. Churn drills shall be set up at right angle to the bank whenever it is possible to do so, but in no event shall the angle be less than 75 degrees.

3. Use cribbing or other timber in good condition for blocking and leveling up.

4. Use jack bar for turning screw jacks and see that bar is properly inserted in jack.

5. Be sure that jacks are set on firm blocking to reduce swaying.

6. Watch for possible loose bank when passing between drill platform and edge of bank.

7. When either member of a drill crew is working near the crest of a bank, he must use a safety belt with rope or chain firmly secured.

C. Starting Hole

1. When starting to drill, the bailer should be in the mud box with no slack in the sand line and with sand-reel lever latched.

2. When setting string of tools on deck, the tools may be pushed or pulled. The method best suited to the individual should be used, bearing in mind the hazard to the feet and also having complete control of the tools at all times. Stand with feet spread well apart for better stance while handling tools.

3. When driller and helper both leave the machine, it must be stopped.

4. Never leave the tools in the hole.

5. The driller must at all times watch the condition of the tools and cable coming out of a hole to determine their condition. If cable shows signs of wear, report to the churn-drill foreman immediately.

6. Keep the drilling cable straight and tightly wrapped on the cable drum.

7. Avoid drilling with slack line, which causes dangerous slap in the cable.

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8. Avoid running bit too long, as this will cause the bit to wear excessively.

9. Straightening crooked hole:

   a. Crooked holes are generally caused by tools having a tendency to follow the dip of the strata when passing from a soft to a hard formation. Crooked holes are also caused by loose drilling.
   b. A crooked hole is generally indicated by a kick on the line as the tools are deflected by the crook in the hole.
   c. Crooked holes may be straightened by filling hole to the point where it changes direction with hard material and then starting to drill again or by blasting hole.
   d. If hole must be sprung, notify the churn-drill foreman. The springing will be done by men from the blasting crew.

D. Placing Casing in Hole

1. Casing must be used when a hole is started.

2. While handling casing, avoid cutting fingers on rough edges or catching fingers in slots. Wear gloves while handling casing.

3. Never hug the casing or place the hands on top of it while it is being driven.

4. The casing is drawn up to the drill by means of the sand line, and a "come-along" is attached to line and casing. (The bailer should be laid down on the deck.) The sand-line reel should be run slowly so that helper may guide casing without danger to himself.

5. Be sure that casing is not too long for the hole.

6. Lower casing into hole and brace with cross blocks. Hold blocks by sides or ends when dropping into place. Never place the hands between the casing and the cross or between the cross and the deck.

7. When placing or removing cheater block between casing and platform, the block should at all times be in a horizontal position. The operator must stop the drill until the block has been removed and properly placed across the platform engaging side of casing.

8. When two or more blocks are being used at the same time, additional precaution must be observed, as the chance of injuring hands or fingers is greater.

9. When casing is slapping, due to being loosely or improperly engaged in the hole, drilling must be stopped until casing is reblocked.

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10. Use casing driver to drive casing and wear goggles during this operation.

11. The bell should be tight to keep tools in line.

12. When placing or removing casing-driver head, be sure that hands and feet are clear of the tools.

13. Never work or place hands or feet under suspended tools.

14. Watch for spudding clutch sticking, which will cause tools to strike several blows and possibly knock driver from casing.

15. Casing should be driven down far enough so that circle jack will not have to be blocked up to remove bit.

16. If casing is too long to permit use of circle jack in its normal position, consult the foreman.

E. Pulling Casing

1. Never use sand reel to pull tight casing. Use casing puller provided for this purpose.

2. Be sure that end plate is screwed on before using casing puller.

3. Stand in the clear, should casing break loose suddenly.

4. Use the same precautions in handling the casing as when the casing is placed in the hole.

F. Changing Bits

1. Bits must always be handled with the chain block or a bar.

2. Bits should always be left lying down on the ground. Never leave them leaning against the machine.

3. Use proper lifting method and protect hands and feet when moving sharp or dull bits.

4. Have the bit lying down to clean threads, unless locked in swivel wrench.

5. Be sure that bit is properly latched in swivel wrench.

6. Never stand under bit while raising and swinging it onto the drill platform.

7. Never make a lift with a kink, knot, or twist in the chain.

8. Be sure that brake is tight, so that tools will not drop when attaching bit.

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9. When bit is being changed, only those tools that are needed to make the change may be on the platform.

10. Before tightening bit, the track of circle jack should be thoroughly cleaned to prevent latch slipping out.

11. Make sure that jack handle is in good condition and properly inserted in the socket before applying pressures. If handle is loose in socket, soak in water barrel to prevent its slipping out of socket.

12. Wooden jack handles may be used for no purpose other than that for which they are intended.

C. Bailing out Hole

1. Protect the eyes while bailing and avoid looking up at cable or bailer as they are drawn from the hole.

2. Avoid running sand line too fast when lowering bailer into hole. Bailer may hang up, causing slack line to loop around operator or cause line to slap.

3. When hoisting bail, be sure that tool guide is in the clear. Avoid jerking bailer when raising it from deck.

4. Taking samples:

a. When possible, bailing must be done with enough water to permit free flow of sludge through splitter box.
b. Bailing must be complete when hole is finished.
c. Sample-cutting slot in the sludge box must not be plugged with waste or rocks to reduce amount of sample flowing into sample tub.
d. When sample tub is filled within 3 inches of the top, it must be removed and replaced with a clean tub.
e. Before going on a new hole, bailers and splitter boxes must be washed clean.
f. When taking samples, bailers must be lowered into the splitter boxes so as to reduce splashing to a minimum.
g. Proper care must be taken of samples and sample containers at all times.

VII. Coordination with Other Jobs

The churn drill crews should cooperate at all times with the other mining operations. They should arrange their work so as to avoid possible delays to shovel or train operations.

VIII. Emergency Procedure

A. Electrical Storms

1. Men must leave churn-drill areas and retire at least 50 feet from any churn drill during an electrical storm.

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2. Stay away from pipe lines, power cables, shovels, or any conductors of electricity. Any piece of equipment attracts electricity, so stay in the open.

3. The judgment of the churn-drill foreman will dictate the necessity for leaving all danger zones and the length of time these zones should be vacated.

B. General Power Failure

1. When a general power failure occurs, the dispatcher will give the power-failure signal on the air whistle: 1 long, 1 short, and 1 long blast (____).

2. This indicates that the power failure is general and that shovels or churn drills are not to start up until notified by the dispatcher.

3. When power fails in the mine, the driller must turn the control on the churn drill to the neutral position.

4. When power comes on, the dispatcher will sound one long blast on the air whistle. This will notify all crews to be on the alert for their call number.

5. Churn drills will resume operations following the shovel on the same bench on which they are operating.

6. Churn drills operating on a bench where more than one shovel is operated will start as soon as the first shovel on the bench has started working. The dispatcher will allow sufficient time interval between shovels for the starting up of the churn drills.

C. Procedure in case the churn-drill mast comes in contact with an overhead power line.

1. Jump clear of the machine, being careful not to touch machine and ground at the same time.

2. Notify pit electrician.

3. Do not allow anyone to approach the machine until clearance is given by the pit electrician.

IX. Procedure to Follow in Case of Injury

1. All accidents resulting in personal injury, regardless of seriousness, must be reported at once to the foreman in charge of the work. The foreman must see that injured employee receives medical treatment and must make out a written report as soon as possible.

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2. In case of serious injury, the hospital must be notified at once, so that a doctor may be summoned to the hospital or to the scene of the accident as dictated by the nature of the injury. If there is any doubt about the doctor locating the place, arrange for a guide. Call hospital. Give the information regarding the nature of the injuries. Also telephone the information to the safety supervisor and to the division superintendent.

3. A card must be issued by the foreman to any man going to the doctor for first treatment on account of an accident.

4. When doubt exists as to an injury occurring during employment and the injured man is being sent to the doctor, the card should be plainly marked "alleged" accident.

5. No employee, who has been ill or injured, will be permitted to return to work without written release issued by the attending physician.

6. A definite procedure prevails with respect to return to the hospital for re-treatment of employees who are injured on the job, as follows:

> When an employee has been injured and returns to work afterward with written release by the doctor, but is required to return to the hospital for further treatment, he will be given a written statement to that effect by the doctor each time that treatment is received for as long as treatment is necessary. When it is no longer necessary for the man to return, the doctor will issue a "discharge notice." Foreman must insist upon getting these statements until discharge notice is received, as this provides assurance that the man has been to the hospital and also provides the foreman with the knowledge as to when the injured employee is to return to the hospital. Employees who are working day shift will be provided with transportation at 7:50 o'clock A. M. to go to the hospital. Injured employees who are working on other shifts are required to go to the hospital during the day time, and they must present their medical redressing slip to the foreman when reporting for work. Foreman must receive slip before allowing the man to go to work.

7. In case of probable fatal injury a doctor and the safety supervisor must be called to the location of the accident.

8. Administer first aid.

   a. If necessary, remove injured man to a place where additional injury will not occur.
   b. Apply first-aid treatment to stop bleeding, if any, and treat for shock. There may be a spark of life.
   c. If the doctor pronounces accident fatal, follow instructions pertaining to fatal accidents.

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Code of Safe Practice for Prospect Drilling

The "Code of Safe Practice for Open-Pit Division Prospect Drilling" is similar to the preceding code. The differences are mainly due to difference in equipment. The prospect drill is drawn by a Diesel engine, and the regular open-pit drills are electrically operated. Some sections of the prospect-drill code that furnish additional information are given:

2. Fishing tools:

   a. Tool bumper
   b. Latch jack
   c. Combination socket
   d. Cable spear
   e. Casing spear
   f. Horn socket
   g. Stem
   h. Jars
   i. Drive down socket

4. Operating catheads (capstan)

   a. No one should attempt to operate the cathead rope unless he has been thoroughly instructed in its proper and safe use, and then only with permission from his foreman or operator.
   b. When catheads are being used, the operator must be in a position to stop the machine instantly.
   c. When taking a pull with the cathead, take a position on the opposite side of the cathead from the object to be pulled.
   d. Never touch the cathead rope on the side that is feeding onto the drum.
   e. Never attempt to straighten out a fouled rope when the cathead is in motion. If a rope becomes fouled, get away from it.
   f. Never stand in the coils of loose rope that are coming off the cathead.
   g. Manipulate the rope by grasping it at a safe distance from the wraps on the cathead. A distance of 2 feet is considered satisfactory.
   h. Keep hands away from the wraps on the drum.
   i. Watch the pull on the rope, and if it appears that the rope may break or that the rope may be under a heavy strain, see that everyone is out of danger.
   j. Use only a rope in good condition for a catline.

5. Handling casing.

   a. When using the cathead to make or break pipe connections, bear in mind that a position in front of or behind the tong handles is dangerous. A person behind the handles would be injured by the backlash if the catline should break.
   b. When using the catline to spin threaded pipe connections, the man holding end of rope which is feeding into the wraps must keep his hands at a safe distance from the pipe.

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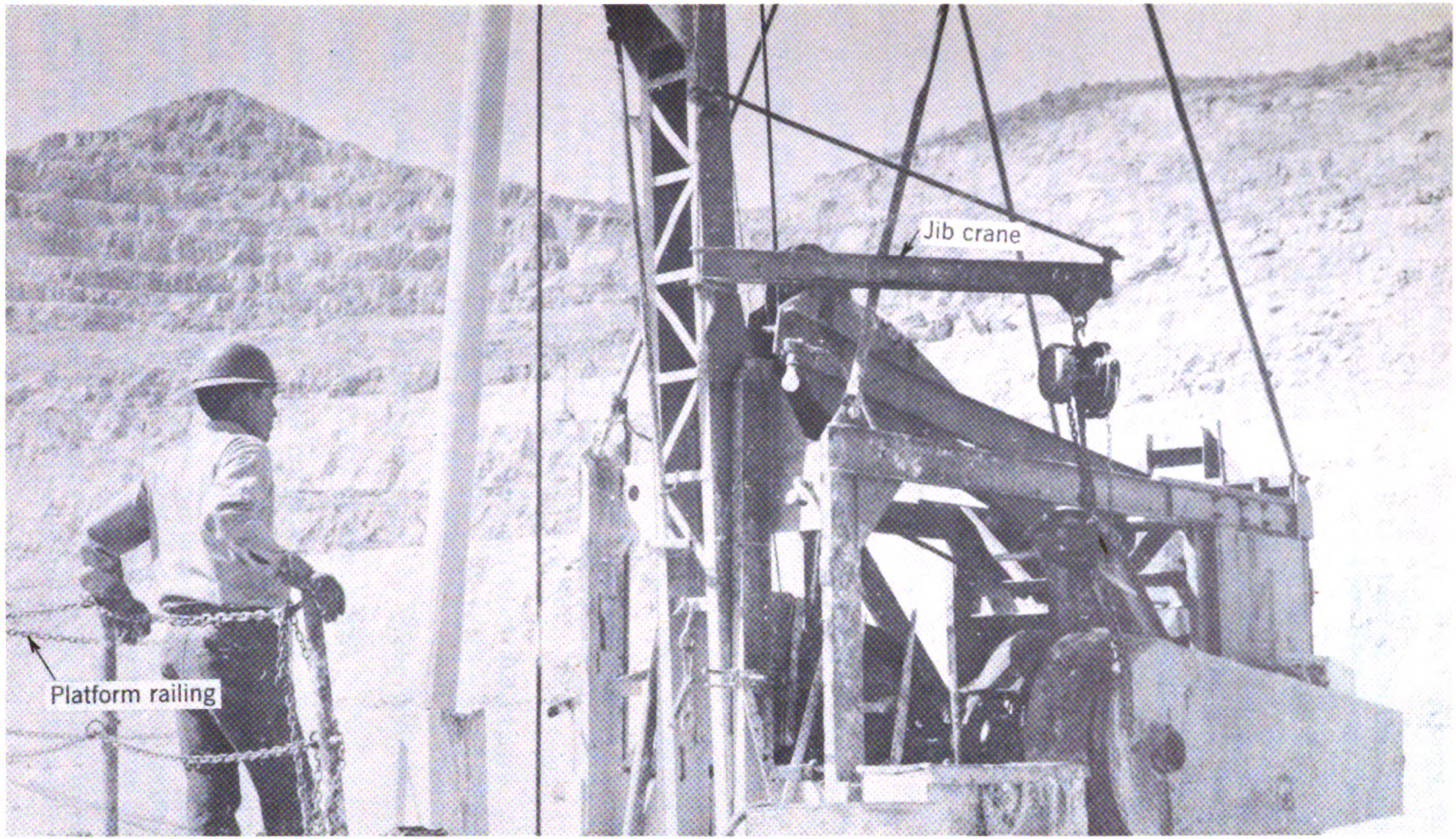

Figure 1. - Churn drill at Morenci open pit.

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c. If rope becomes fouled on pipe, do not attempt to untangle it. Wait for the machine to stop.
d. The cathead operator must be alert to release tension when necessary, and the drill operator must be prepared to stop the machine instantly.
e. When handling elevators to pick up or lay down pipe, keep fingers and toes clear of pinch points.
f. Guard against mashing fingers or toes and against falling while guiding casing and tools onto and off the deck.
g. Persons on the mast platform to stab casing must be secured to the mast with a safety belt and rope or chain.
h. All persons should stand well back from the machine when the operator is taking a heavy pull on pipe or drilling tools.

D. Fire Protection.

1. Stop the power plant before putting gasoline in the starting motor tank.

2. Avoid spilling gasoline or fuel oil, particularly on the person, clothing, or on hot motor.

3. Allow no open lights or smoking while fuel tanks are being filled.

4. No fires are permitted, except in an approved type of stove.

5. Never feed a fire with gasoline or fuel oil.

6. Do not transfer fuel from one vehicle tank to another.

7. Gasoline or fuel oil carried on vehicles must be in approved air-tight containers. Set the can on the ground to release the static charge before starting to pour.

8. Know the location of fire extinguishers and report to foreman when fire extinguisher is used. If extinguisher is not available, smother the fire with dirt.

9. Always keep fire extinguisher in the place provided.

SAFETY FEATURES OF EQUIPMENT

A number of safety features were noted at Morenci around the churn drills; many of these, added in the local shop to early models, are built into newer equipment. A removable railing is placed around the hinged wooden drill platform, added to give ample working space for the crew (fig. 1). Steel grab irons have been welded on the tops of the masts to afford men a handhold during greasing or inspection. A safety chain, fastened to the tool guide, is installed to prevent the tool guide from falling, if it should loosen from the derrick. The sand-line sheave is welded solidly to the mast instead of relying on U-bolts, with consequent additional chance for wear. The casing puller in use at Morenci was designed at the mine. It is not necessary to hold in the hands, and in case

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of breakage will fall inside the casing. This tool is used for driving casing when the casing is first started but is followed by use of a regular casing driver, also designed and fabricated at Morenci. The casing driver consists of a square piece of boiler plate at least 1-inch thick welded to a piece of casing that will fit inside the casing to be driven. When driving a 10-inch casing, the plate will be welded to a piece of 8-inch casing 8 inches long. To insure that the correct size of driver is used, it is marked with a welded-bead numeral designating the size of casing on which the driver is to be used.

A steel plate 1-inch thick is welded to the back of the mast to prevent the pitman from crashing through if the pin holding it should fail (fig. 2). A lineman's hook is used with the sand line to lift casing, pull casing (rarely done), and to pull bits to the drill (fig. 2). A catch is placed on the spudding-clutch lever to prevent it from being pulled out inadvertently. Ratchet controls were added on the bull-reel control lever and on the propelling clutch and brake-control levers. Bits are changed by means of an I-beam jib crane, attached to the mast and equipped with a chain block (fig. 1). Steps have been provided for ease in mounting the drill platform, and beads are welded to both the steel platform and steps for more secure footing.

SAFETY MEETINGS

The churn drillers and helpers hold monthly safety meetings on each shift with the churn-drill repair crews, samplers, and transportation crews under the supervision of the churn-drill foreman. An outline suggested by the safety department aids in furnishing a suitable program for the meeting. Reports are given on all lost-time and no-lost-time accidents that occurred since the previous meeting; instructions on safe practice are given; and attention is called to all poor practices observed. Action taken on safety suggestions is explained. A secretary is appointed to keep the minutes of each meeting.

CONCLUSION

Although mechanical failures occur on rare occasions, the majority of accidents around churn drills are caused by human errors. The code of safe practice described herein points out the obvious hazards of operation and serves as a guide for safe procedure, which, if followed, will eliminate many of the unsafe acts that result in accidents. Familiarity with the code is obtained by frequent review, and safety consciousness, so necessary for accident prevention, is encouraged by a continuing safety program in which each individual has an active part.

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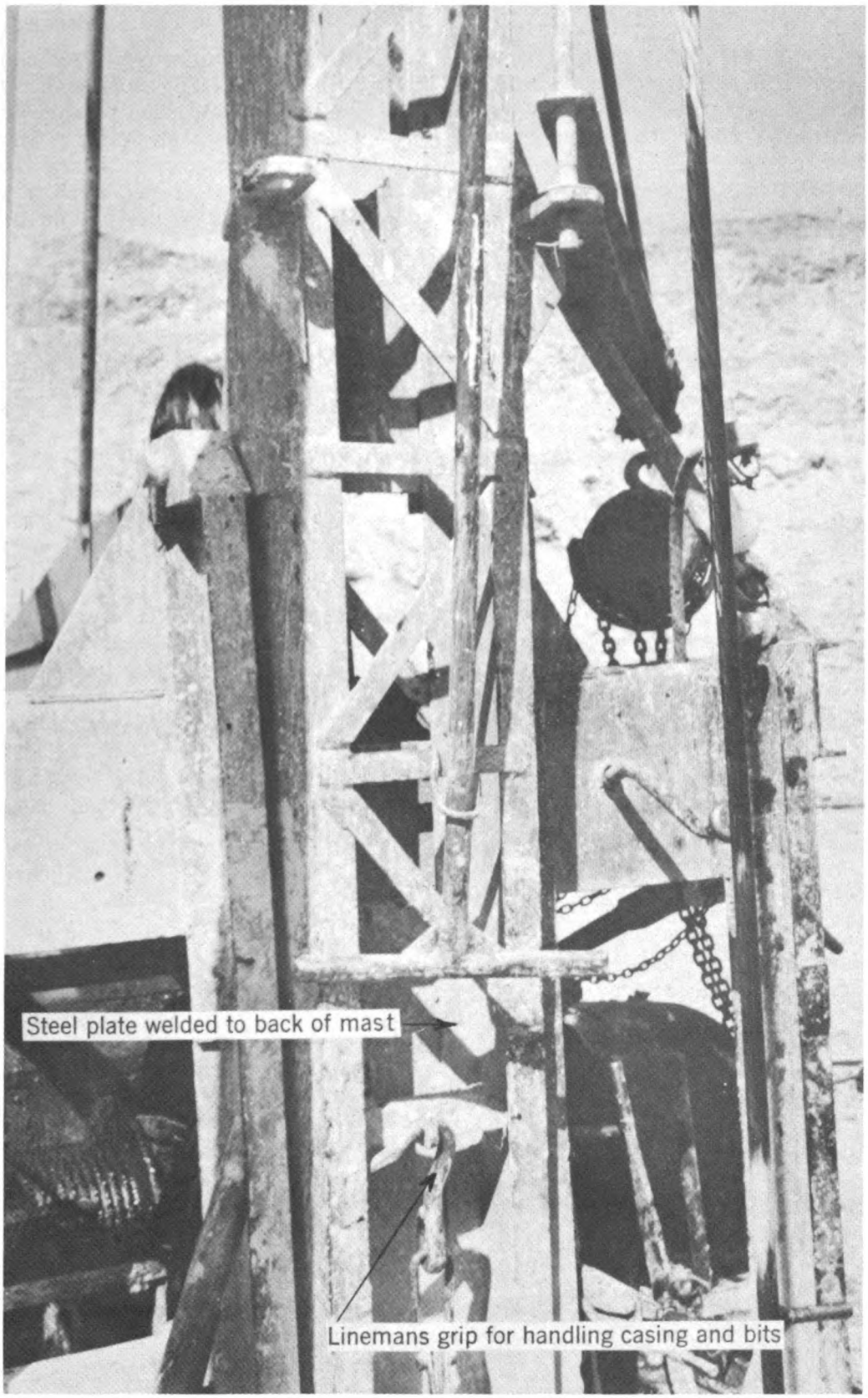

Figure 2. - Steel plate to prevent pitman from crashing through mast.

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